

NORMAL TEE EXAMINATION: APPLICATIONS, PITFALLS, PROBE INSERTION & MANIPULATION, RISKS & COMPLICATIONS



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ASCeXAM/ReASCE
REVIEW COURSE

The most comprehensive review to help you prepare for the NSE certification examinations.

ANNUAL
19th

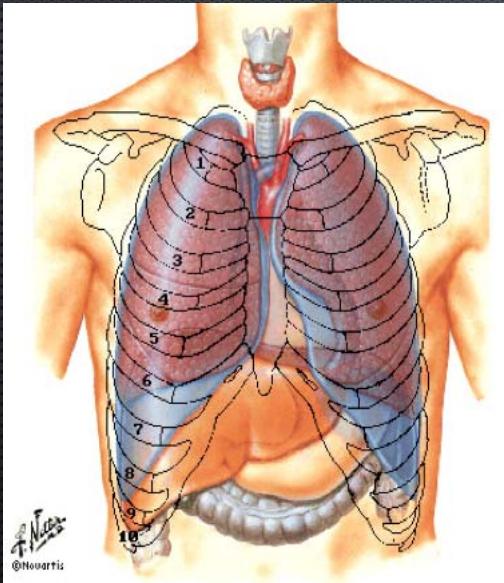
DISCLOSURES

- NO FINANCIAL DISCLOSURES
- NO CONFLICTS OF INTEREST

ROBUST POWER OF TRANSTHORACIC ECHO

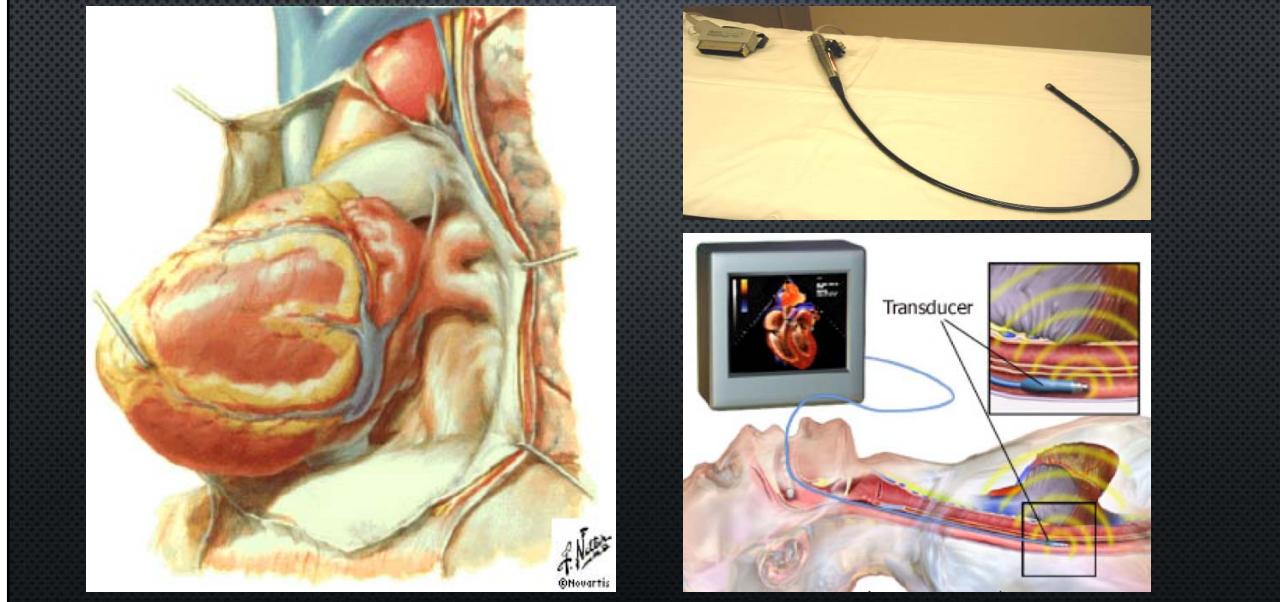
- **LEFT HEART**
 - LV / LA SIZE
 - SYSTOLIC
 - DIASTOLIC
 - ISCHEMIC DISEASE
- **VALVES**
 - STENOSIS
 - REGURGITATION
 - PROSTHETIC
- **MASSES**
 - ENDOCARDITIS
 - THROMBUS
 - TUMORS
- **RIGHT HEART**
 - SIZE AND FUNCTION
 - RV VALVES
 - PULMONARY HYPERTENSION
- **AORTA**
 - ROOT & PROXIMAL ASCENDING
 - AORTIC ARCH
- **CONGENITAL**
 - SEPTAL DEFECTS / PFO
 - AV CANAL & VARIANTS
 - TETRALOGY OF FALLOT
 - TGA
 - BAFFLES AND SHUNTS

FAILURE OF TRANSTHORACIC ECHO



- **POOR TRANSMISSION**
 - PULMONARY DISEASE
 - OBESITY / EXTREME UNDERWEIGHT
- **POOR RESOLUTION**
 - STRUCTURES <3 MM
- **POOR VISUALIZATION**
 - LEFT ATRIAL APPENDAGE
 - PV MORPHOLOGY
 - COMPLETE AORTIC EVALUATION
- **PROCEDURE GUIDANCE**
 - ASD CLOSURE, PVL CLOSURE
 - TRANSCATH VALVES, REPAIRS, LAA OCCLUDERS

YOU KNEW YOU WANTED INVASIVE CARDIOLOGY!



WE REVERE THE HOLY TEE MANUSCRIPT

ASE GUIDELINES AND STANDARDS

Guidelines for Performing a Comprehensive Transesophageal Echocardiographic Examination: Recommendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists

Rebecca T. Hahn, MD, FASE, Chair, Theodore Abraham, MD, FASE, Mark S. Adams, RDCS, FASE, Charles J. Bruce, MD, FASE, Kathryn E. Glas, MD, MBA, FASE, Roberto M. Lang, MD, FASE, Scott T. Reeves, MD, MBA, FASE, Jack S. Shanewise, MD, FASE, Samuel C. Siu, MD, FASE, William Stewart, MD, FASE, and Michael H. Picard, MD, FASE, New York, New York; Baltimore, Maryland; Boston, Massachusetts; Rochester, Minnesota; Atlanta, Georgia; Chicago, Illinois; Charleston, South Carolina; London, Ontario, Canada; Cleveland, Ohio

J Am Soc Echocardiogr (2013) 26:21-64

INDICATIONS FOR TEE

GENERAL

- TTE NON-DX, FINDINGS CRITICAL
 - VENTILATED PATIENTS
 - BODY HABITUS LIMITATIONS
 - CHEST WALL INJURY / INCISION
- LEFT ATRIAL APPENDAGE
- THORACIC AORTA
- SMALL STRUCTURES (<3MM)
- FAR-FIELD TTE STRUCTURES
- PROSTHETIC VALVES
- ABSCESSSES

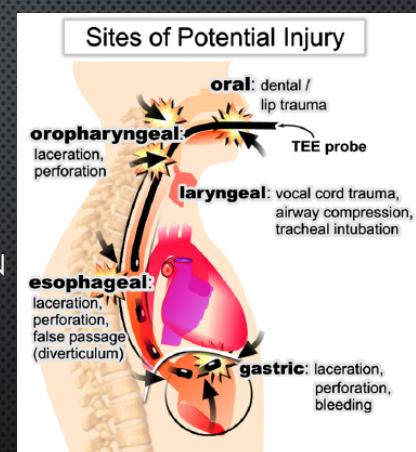
SPECIALIZED

- CRITICALLY ILL
 - EMERGENCY DIAGNOSIS
 - HEMODYNAMIC MONITORING
- PROCEDURE GUIDANCE
 - SEPTAL CLOSURE
 - TRANSCATHETER VALVES / PLUGS
 - VALVULOPLASTY
 - LA APPENDAGE OCCLUDE
- INTRAOPERATIVE
 - CARDIAC (VALVES, RISKY CABG)
 - NONCARDIAC

Adapted from: Hahn RT, et al. JASE (2013) 26:921-64

POTENTIAL COMPLICATIONS – PASSING PROBE

- **ORAL**
 - LIP TRAUMA, TOOTH DAMAGE/LOSS
- **PHARYNGEAL**
 - LACERATION, HEMATOMA, PERFORATION
 - LARYNGOSPASM
 - VOCAL CORD TRAUMA, TRACHEAL INTUBATION
- **ESOPHAGEAL**
 - PERFORATION, LACERATION, DIVERTICULUM
- **GASTRIC**
 - LACERATION, PERFORATION



Hilberath JN, et al. JASE (2010) 23:1115-1127

POTENTIAL COMPLICATIONS – 2

- **ASPIRATION**
 - CHEMICAL, BACTERIAL (PNEUMONIA)
- **SEDATION-RELATED**
 - HYPOXEMIA, HYPERCAPNIA, AIRWAY OBSTRUCTION
- **THERMAL**
 - ESOPHAGEAL / GASTRIC BURN (INCL. BLEEDING, PERFORATION)
 - WATCH THE TEMPERATURE!! FREEZE EARLY
- **PRESSURE-RELATED**
 - OVER-FLEXION, ESPECIALLY WITH PROBE RETRACTION
 - LEAVE IN “NEUTRAL” IN TRANSGASTRIC

Hilberath JN, et al. *JASE* (2010) 23:1115-1127

COMPLICATIONS

Complication	Frequency
Overall Complication Rate	0.18 - 2.8%
Mortality	<0.01 - 0.02%
Major Bleeding	<0.01%
Bronchospasm	0.06 – 0.07%
Dysphagia	1.8%
Hoarseness	12%
Lip Injury	13%

Condensed from: Hahn et al. *JASE* (2013) 26:921-64

ABSOLUTE CONTRAINDICATIONS

- ESOPHAGEAL PATHOLOGY
 - STRICTURE
 - DIVERTICULUM
 - MALLORY-WEISS TEAR
 - SCLERODERMA
 - TUMOR
 - TRAUMA
- KNOWN PERFORATION
 - ESOPHAGUS
 - STOMACH
- ACTIVE / RECENT GI BLEEDING
 - HEMATEMESIS, MELENA
 - RECENT DROP IN HEMOGLOBIN
- RECENT GI SURGERY
 - ESOPHAGECTOMY
 - BARIATRIC PROCEDURE
 - ESOPHAGOGASTRECTOMY
- RECENT OROPHARYNGEAL SURGERY

RELATIVE CONTRAINDICATIONS

- DYSPHAGIA
- LESSER UGI DISEASE
 - ESOPHAGITIS, PEPTIC ULCER
 - VARICES
 - BARRETT'S ESOPHAGUS
 - DISTANT GI SURGERY
 - TREATED STRICTURES
- CERVICAL ABNORMALITIES
 - ATLANTO-AXIAL JOINT DISEASE
 - SEVERE CERVICAL ARTHRITIS
- HEMATOLOGIC ABNORMALITIES
 - COAGULOPATHY
 - THROMBOCYTOPENIA
- OROPHARYNGEAL ABNORM.
 - MALLAMPATI SCORE
 - LOOSE TEETH, PROSTHESES
- UNSTABLE RESPIRATORY STATUS

APPROPRIATE USE CRITERIA

- ✓ TEE WHEN A HIGH LIKELIHOOD OF NON-DIAGNOSTIC TTE
- ✓ RE-EVALUATION OF PRIOR TEE FINDING WHEN MANAGEMENT MAY CHANGE
- ✓ GUIDANCE DURING NON-CORONARY CARDIAC INTERVENTIONS
- ✓ SUSPECTED ACUTE AORTIC PATHOLOGY
- ✓ EVALUATION OF VALVE STRUCTURE AND FUNCTION IN PLANNING FOR INTERVENTION OR SURGERY
- ✓ DIAGNOSE ENDOCARDITIS WITH MODERATE-HIGH PRETEST PROBABILITY
- ✓ EVALUATE FOR CARDIAC SOURCE OF EMBOLUS WITHOUT A NON-CARDIAC SOURCE
- ✓ FACILITATE DECISION MAKING REGARDING ANTICOAGULATION, CARDIOVERSION OR ABLATION IN AF

Douglas et al. 2011 AUC Echocardiography. JASE 2011;24:229-67

APPROPRIATE USE CRITERIA

- ❖ ROUTINE USE OF TEE WHEN TTE IS DIAGNOSTIC
- ❖ RE-EVALUATION OF PRIOR TEE FINDING WHEN NO CHANGE IN THERAPY IS ANTICIPATED
- ❖ ROUTINE EVALUATION OF PULMONARY VEINS IN ASYMPTOMATIC PATIENT POST PVI
- ❖ DIAGNOSE INFECTIVE ENDOCARDITIS IN LOW PRETEST PROBABILITY PATIENTS
- ❖ EVALUATION FOR CARDIAC SOURCE OF EMBOLUS IN A PATIENT WITH A KNOWN CARDIAC SOURCE
- ❖ EVALUATION OF A PATIENT WITH AF WHEN DECISION HAS BEEN MADE TO ANTICOAGULATE AND CARDIOVERSION IS NOT PLANNED

Douglas et al. 2011 AUC Echocardiography. JASE 2011;24:229-67

PATIENT PREPARATION

- NPO FOR 6 HOURS PRIOR TO STUDY
 - MINIMAL CLEAR LIQUIDS ACCEPTABLE
- PERIPHERAL IV ACCESS
- RISK STRAT – ANESTHESIA COMPLICATIONS
 - MALLAMPATI, ASA PHYSICAL STATUS
- AIRWAY EQUIPMENT
 - BITE BLOCK, O₂ SOURCE, SUCTION DEVICES
- BP, HR, SaO₂, RR MONITORING
- ACLS SUPPORT EQUIPMENT / CERTIFIED STAFF MEMBER



MODERATE CONSCIOUS SEDATION

- TOPICAL ANESTHESIA
 - BENZOCAINE, CETACAIN OR VISCOUS LIDOCAINE
 - METHEMOGLOBINEMIA RISK (BENZOCAINE) 0.07% - 0.12%
- CONSCIOUS SEDATION
 - SMALL, INCREMENTAL DOSES OF SHORT ACTING BENZODIAZEPINES
 - ADJUNCTIVE OPIOIDS FOR SYNERGISTIC EFFECT
 - PROPOFOL (*TYPICALLY ADMINISTERED BY ANESTHESIA*)

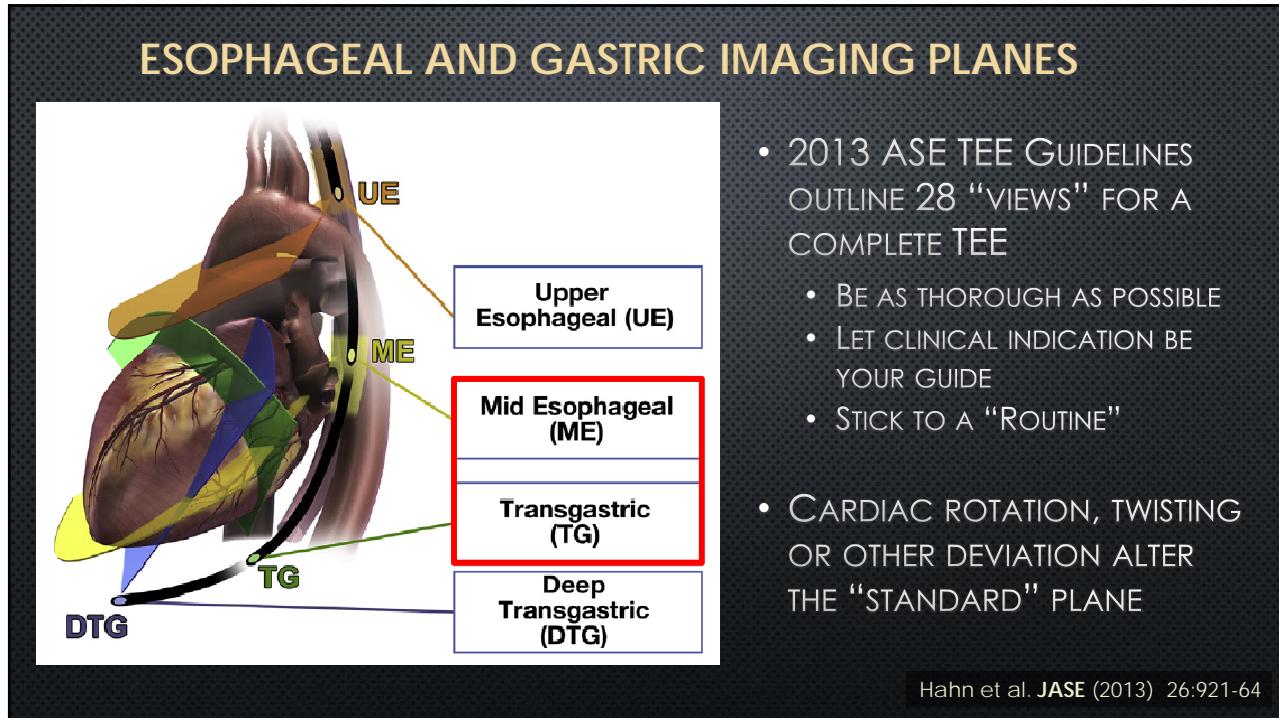
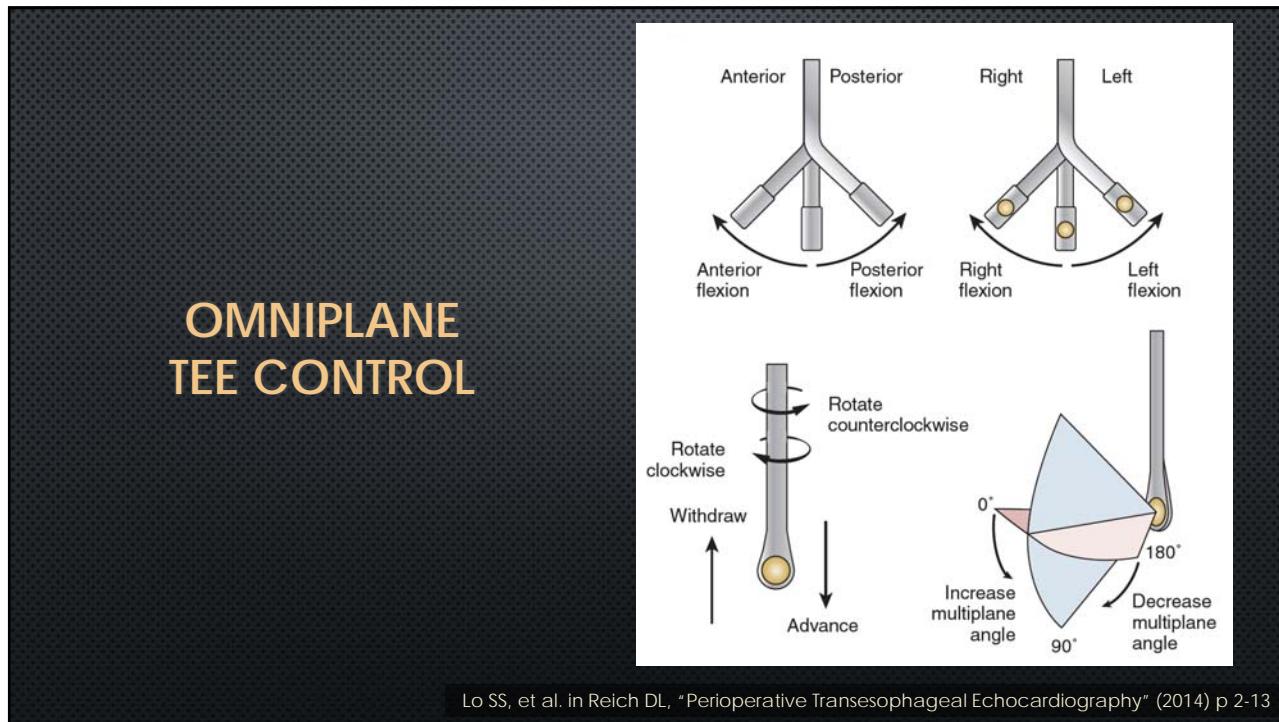
LIVE A LIFE OF MODERATION!!

	Minimal Anxiolysis	Moderate <i>Conscious Sedation</i>	Deep Analgesia	General Anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response to painful stimulation	Unarousable, even with painful stimulus
Airway	Unaffected	No intervention	Intervention may be required	Intervention often required (Intubation)
Spontaneous Ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
CV Function	Unaffected	Usually Maintained	Usually Maintained	May be impaired

"Continuum of Depth of Sedation: Definition of Anesthesia and Levels of Sedation"
Am Soc Anesthesiol (2014)

SPECIAL CONDITIONS

- ICU VENTILATED PATIENT
 - TOPICAL ANESTHESIA, BITE BLOCK
 - VARYING DEGREES OF SEDATIVES ALREADY ONBOARD
 - CAREFUL INSERTION TO AVOID ENDOTRACHEAL TUBE DISLODGEMENT
 - NASO- / ORO-GASTRIC TUBE REMOVAL OR RE-CHECKING
- OPERATING ROOM
 - PATIENT SUPINE FOR SURGERY, BITE BLOCK AFTER INSERTION
 - TEE PROBE INSERTED FROM HEAD OF BED
 - MANDIBLE LIFT CAN FACILITATE ESOPHAGEAL INTUBATION



ESOPHAGEAL VIEWS:

Imaging Plane	3D Model	2D TEE Image	Acquisition Protocol	Structures Imaged
Midesophageal Views				
1. ME 5-Chamber View			Transducer Angle: ~ 0 - 10° Level: Mid-esophageal Maneuver (from prior image): NA	Aortic valve LVOT Left atrium/Right atrium Left ventricle/Right ventricle/IVS Mitral valve ($A_1A_2-P_1$) Tricuspid valve
2. ME 4-Chamber View			Transducer Angle: ~ 0 - 10° Level: Mid-esophageal Maneuver (from prior image): Advance ± Anteflex	Left atrium/Right atrium IAS Left ventricle/Right ventricle/IVS Mitral valve ($A_1A_2-P_1$) Tricuspid valve
3. ME Mitral Commisural View			Transducer Angle: ~ 50 - 70° Level: Mid-esophageal Maneuver (from prior image): NA	Left atrium Coronary Sinus Left ventricle Mitral Valve ($P_3-A_1A_2-P_1$) Papillary muscles Chordae tendinae
4. ME 2-chamber View			Transducer Angle: ~ 80 - 100° Level: Mid-esophageal Maneuver (from prior image): NA	Left atrium Coronary sinus Left atrial appendage Left ventricle Mitral valve ($P_3-A_1A_2$)

Hahn et al. JASE (2013) 26:921-64

TRANSGASTRIC VIEWS

Transgastric Views	Transducer Angle:	Level:	Structures Imaged
16. TG Basal SAX View	~ 0 - 20°	Transgastric Maneuver (from prior image): Advance ± Anteflex	Left ventricle (base) Right ventricle (base) Mitral valve (SAX) Tricuspid valve (short-axis)
17. TG Mid Papillary SAX View	~ 0 - 20°	Transgastric Maneuver (from prior image): Advance ± Anteflex	Left ventricle (mid) Papillary muscles Right ventricle (mid)
18. TG Apical SAX View	~ 0 - 20°	Transgastric Maneuver (from prior image): Advance ± Anteflex	Left ventricle (apex) Right ventricle (apex)
19. TG RV Basal View	~ 0 - 20°	Transgastric Maneuver (from prior image): Anteflex	Left ventricle (mid) Right ventricle (mid) Right ventricular outflow tract Tricuspid Valve (SAX) Pulmonary Valve
	~ 0 - 20°	Transducer Angle: Level: Transgastric	Right atrium Right ventricle Right ventricular

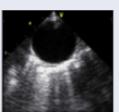
Hahn et al. JASE (2013) 26:921-64

AORTIC VIEWS

Aortic Views



25. Descending Aorta SAX View

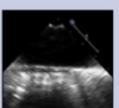


Transducer Angle:
 $\sim 0 - 10^\circ$
Level: Transgastric to Mid-esophageal
Maneuver (from prior image): Neutral flexion

Descending aorta
Left thorax
Hemiazygous and
Azygous veins
Intercostal arteries



26. Descending Aorta LAX View

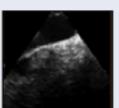


Transducer Angle:
 $\sim 90 - 100^\circ$
Level: Transgastric to Mid-esophageal
Maneuver (from prior image): Neutral flexion

Descending aorta
Left thorax



27. UE Aortic Arch LAX View

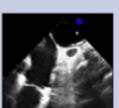


Transducer Angle:
 $\sim 0 - 10^\circ$
Level: Upper Esophageal
Maneuver (from prior image): Withdrawl

Aortic arch
Innominate vein
Mediastinal tissue



28. UE Aortic Arch SAX View

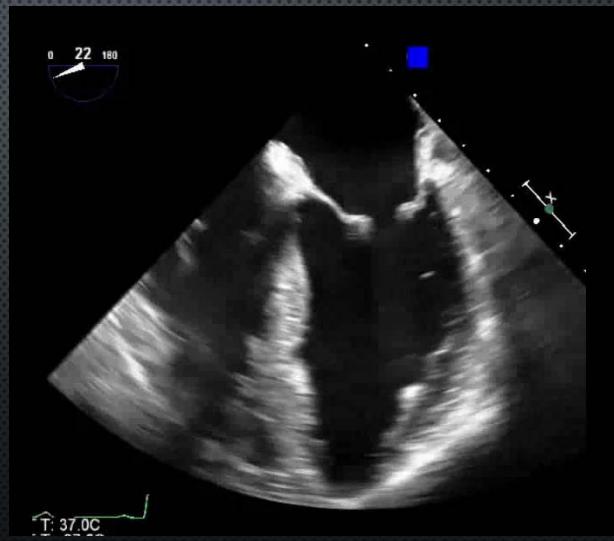
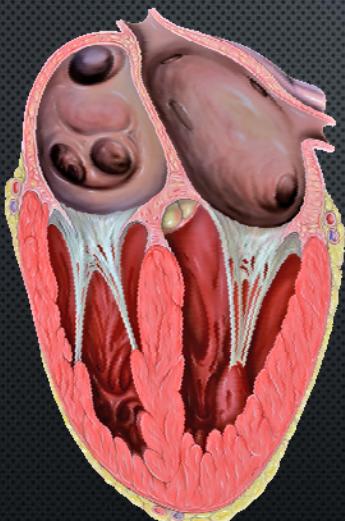


Transducer Angle:
 $\sim 70 - 90^\circ$
Level: Transgastric to Mid-esophageal
Maneuver (from prior image): NA

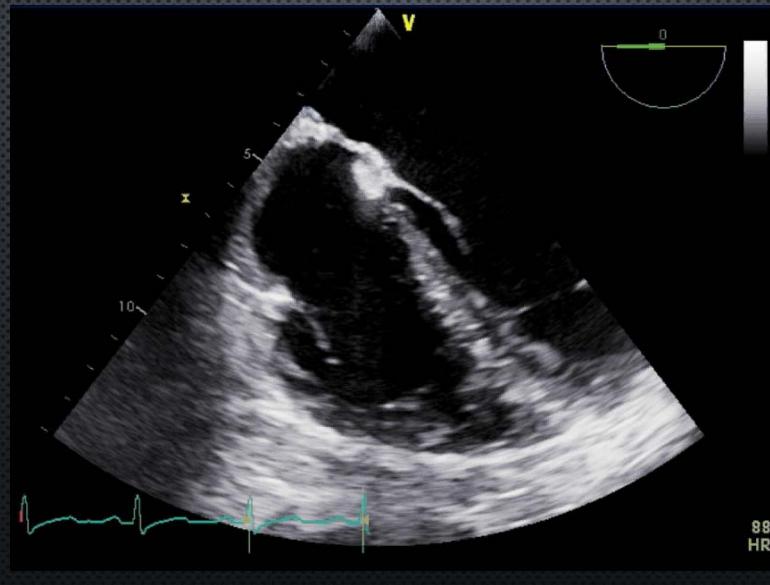
Aortic arch
Innominate vein
Pulmonary artery
Pulmonary valve
Mediastinal tissue

Hahn et al. JASE (2013) 26:921-64

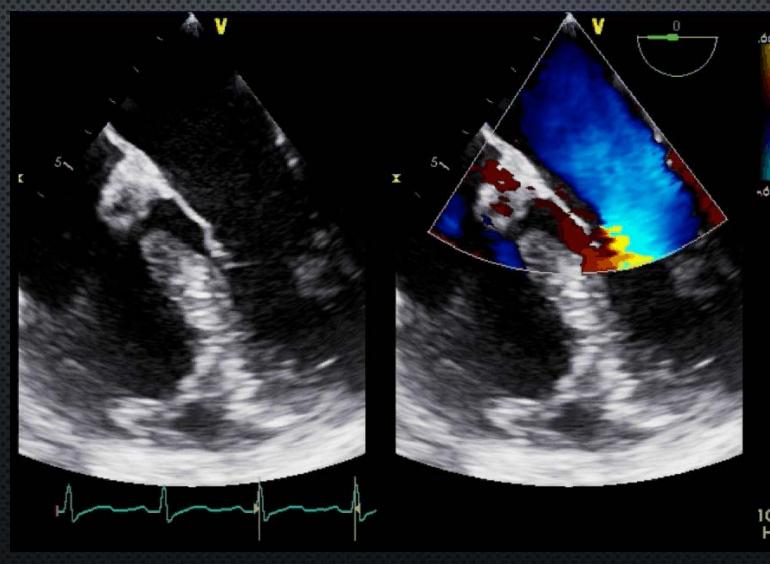
FOUR CHAMBER VIEW



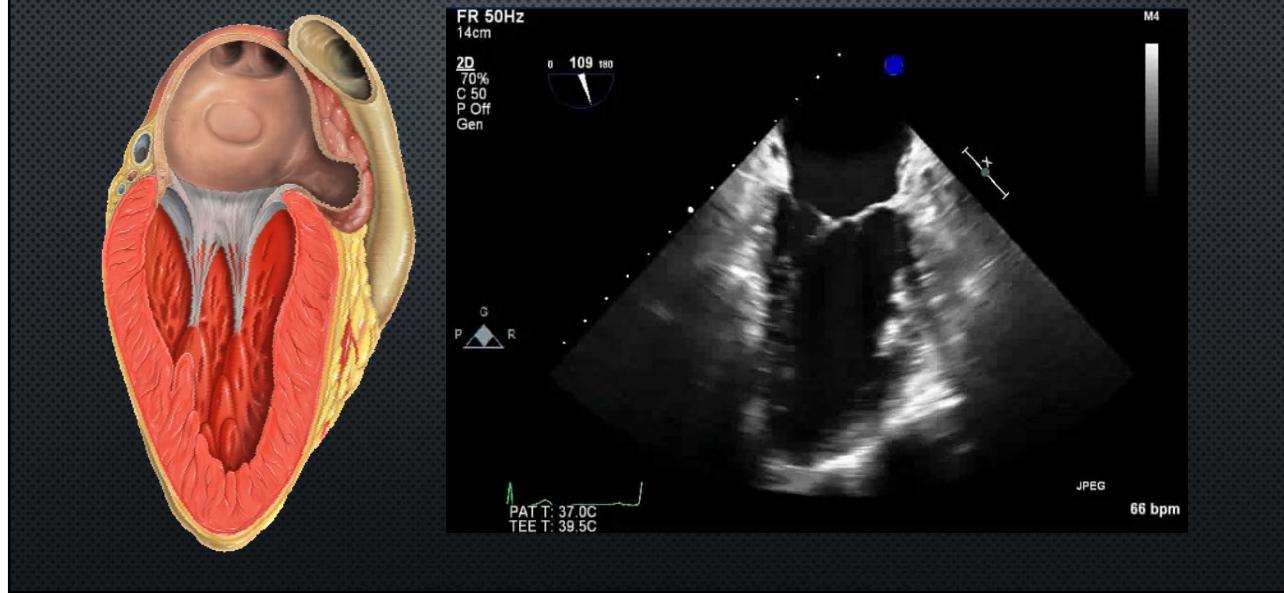
TILTED FOUR CHAMBER VIEW



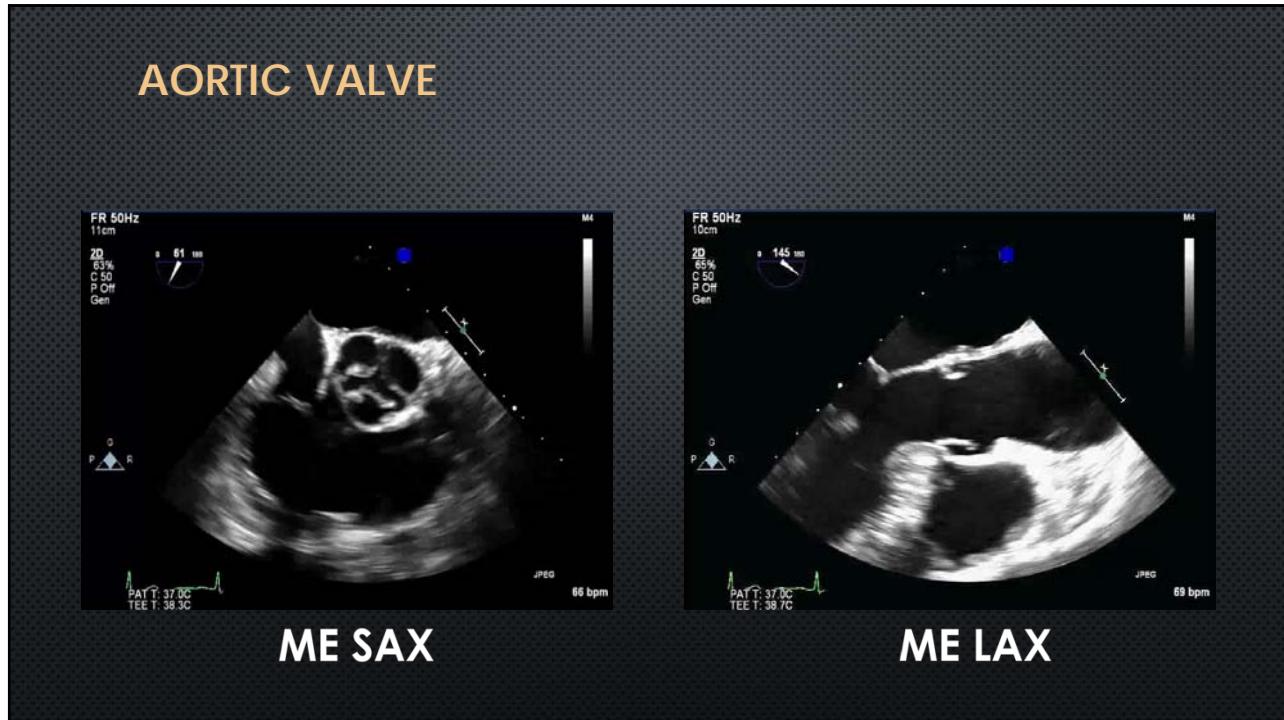
FOUR CHAMBER VIEW CFD



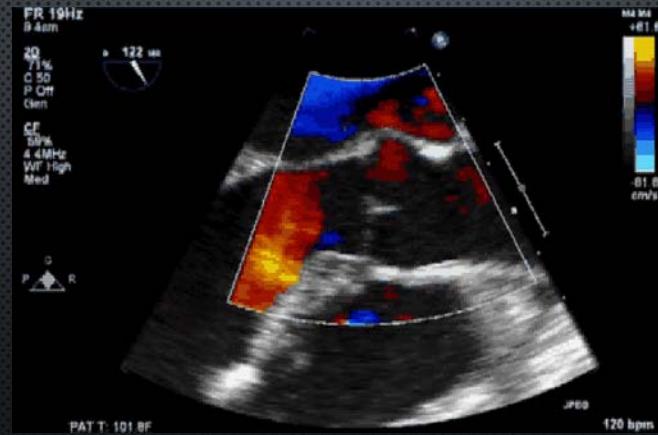
TWO CHAMBER VIEW



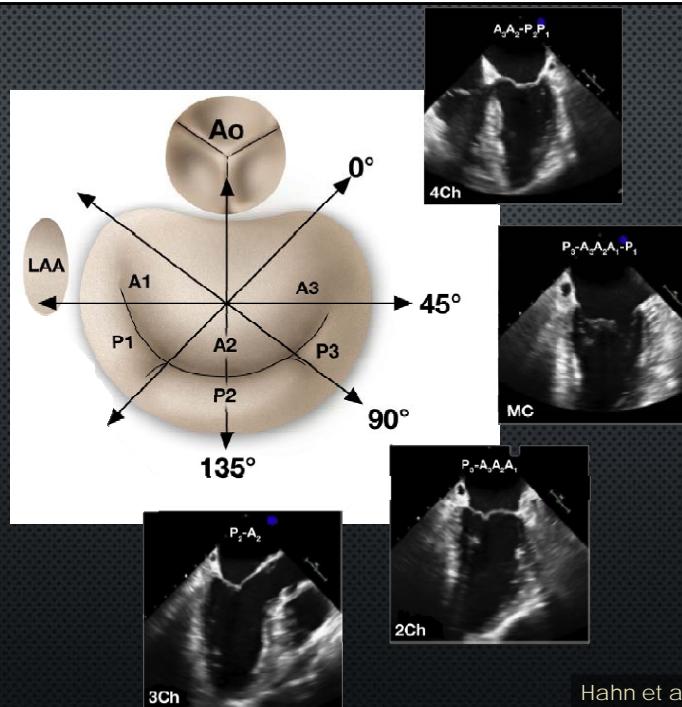
AORTIC VALVE



AORTIC VALVE CFD

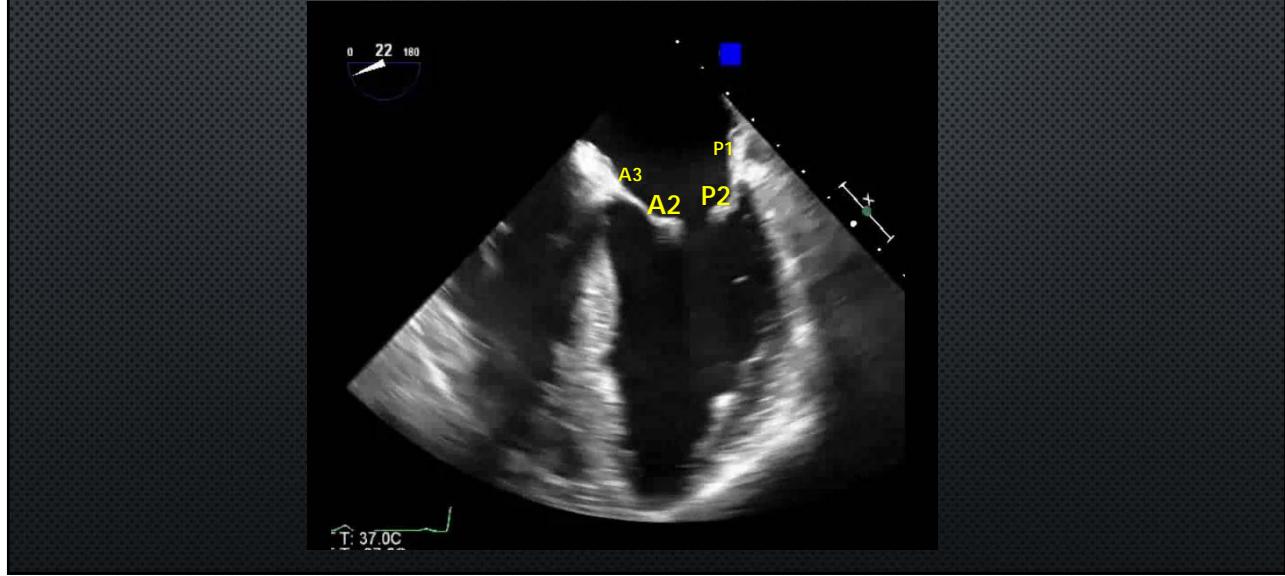


MITRAL VALVE

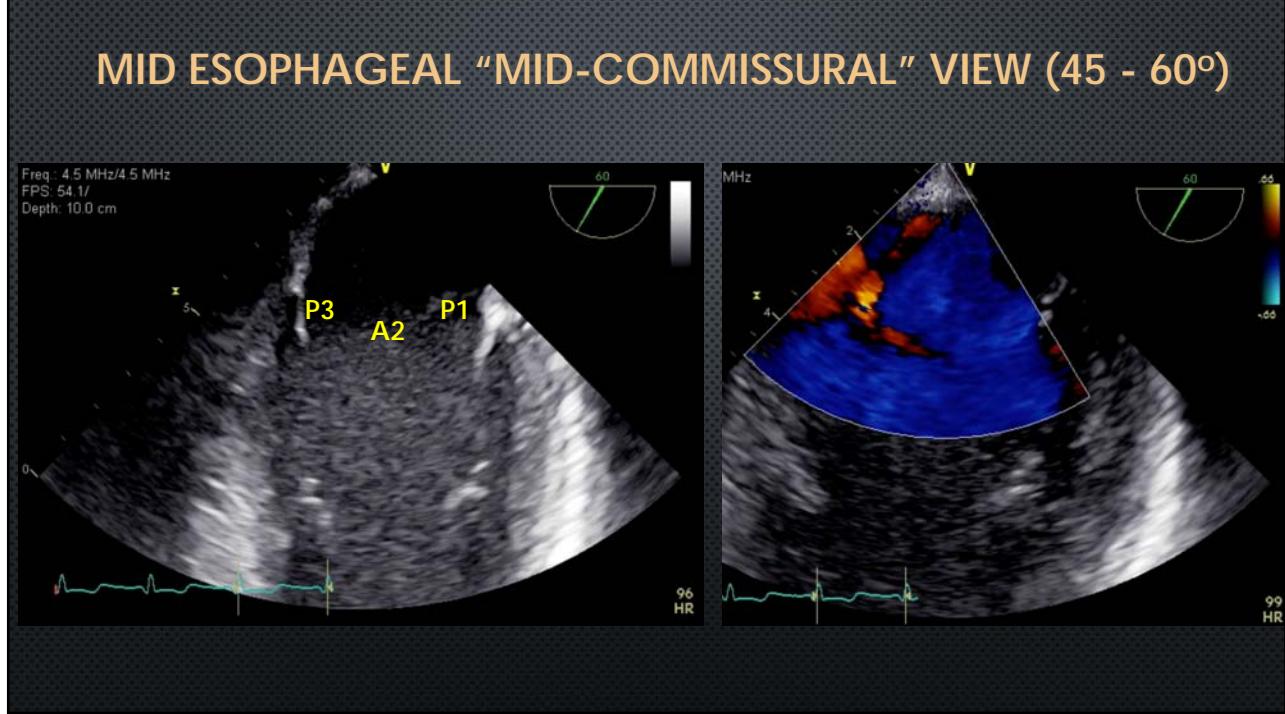


Hahn et al. JASE (2013) 26:921-64

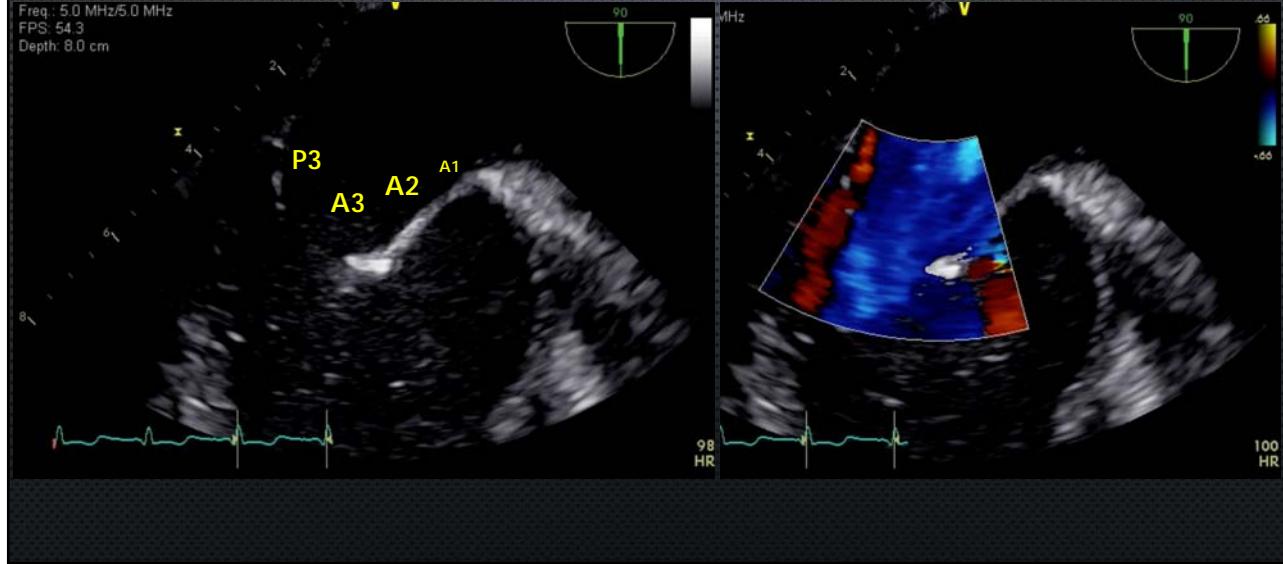
MID ESOPHAGEAL "4 CHAMBER" VIEW (0 - 20°)



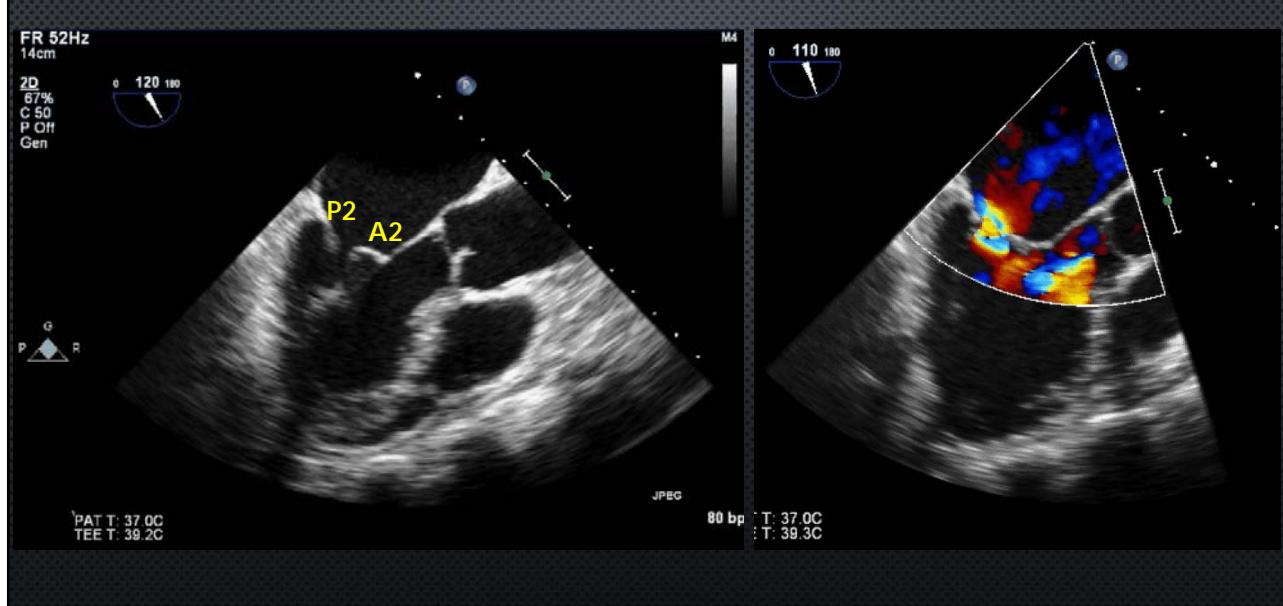
MID ESOPHAGEAL "MID-COMMISSURAL" VIEW (45 - 60°)



MID ESOPHAGEAL "2 CHAMBER" VIEW (90°)



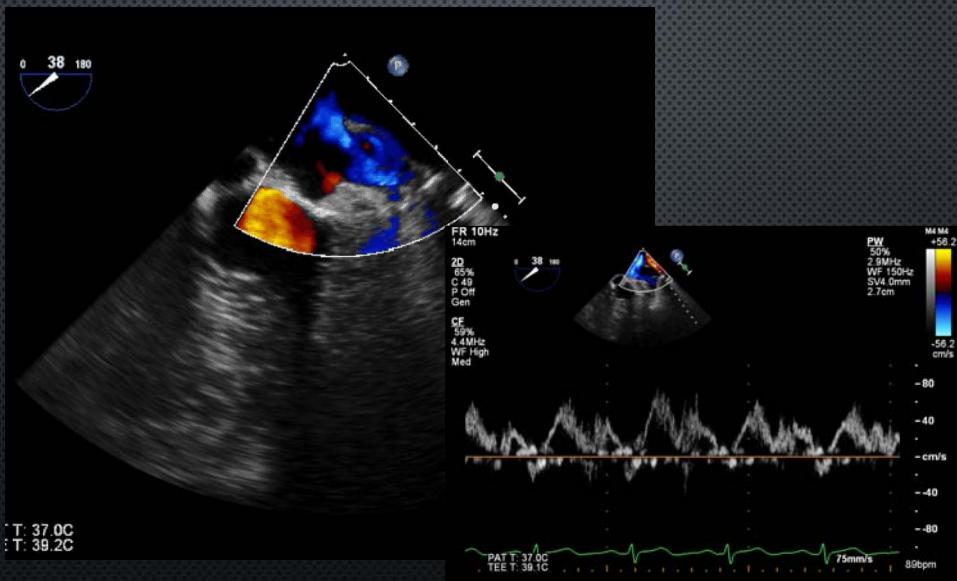
MID ESOPHAGEAL "3-CHAMBER" VIEW (120 - 135°)



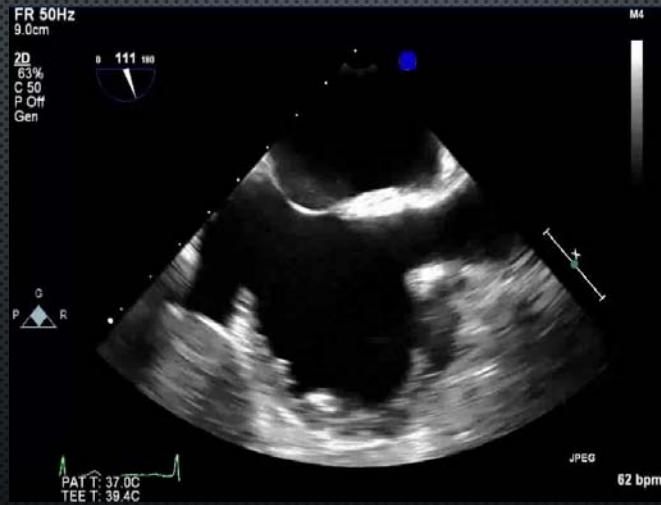
ME LEFT ATRIAL APPENDAGE



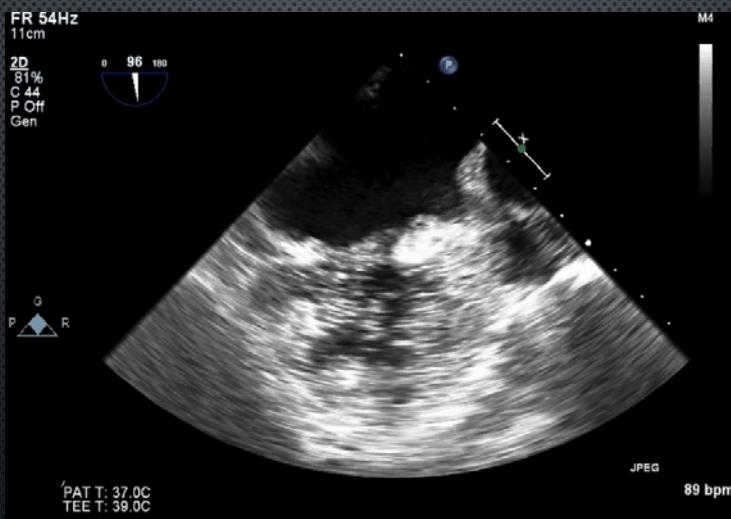
ME PULMONARY VEINS



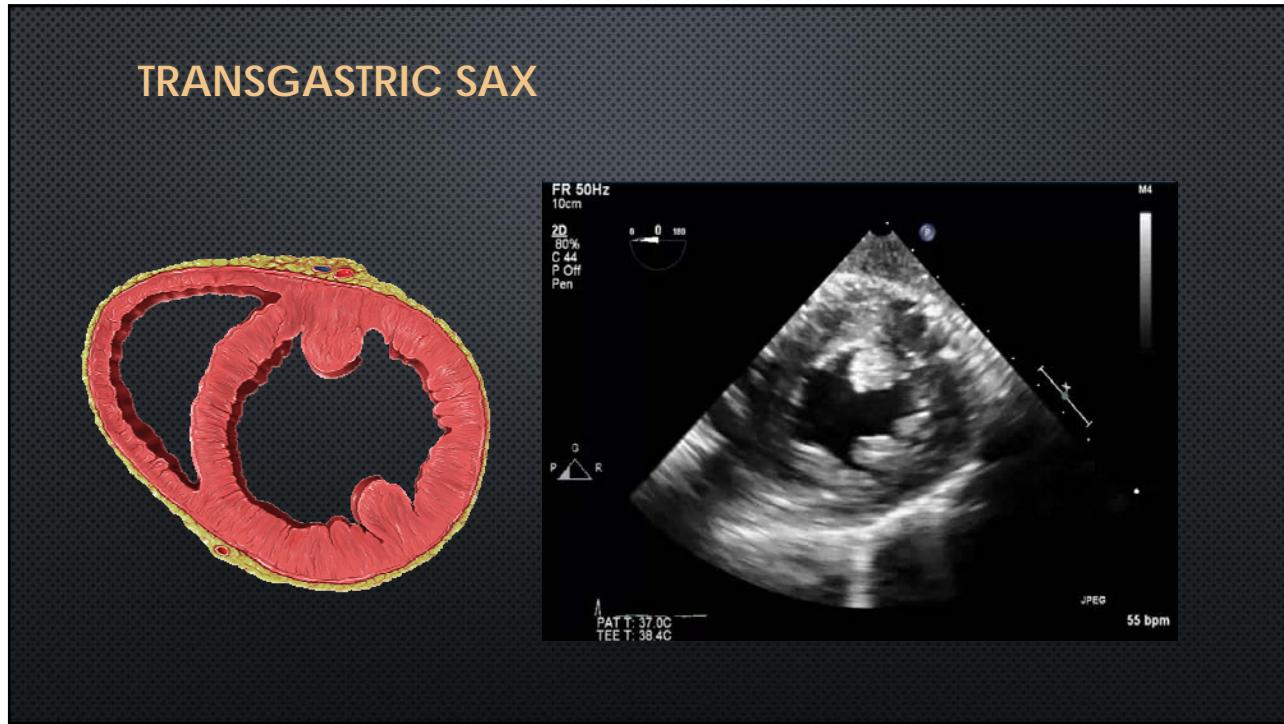
ME BICAVAL VIEW



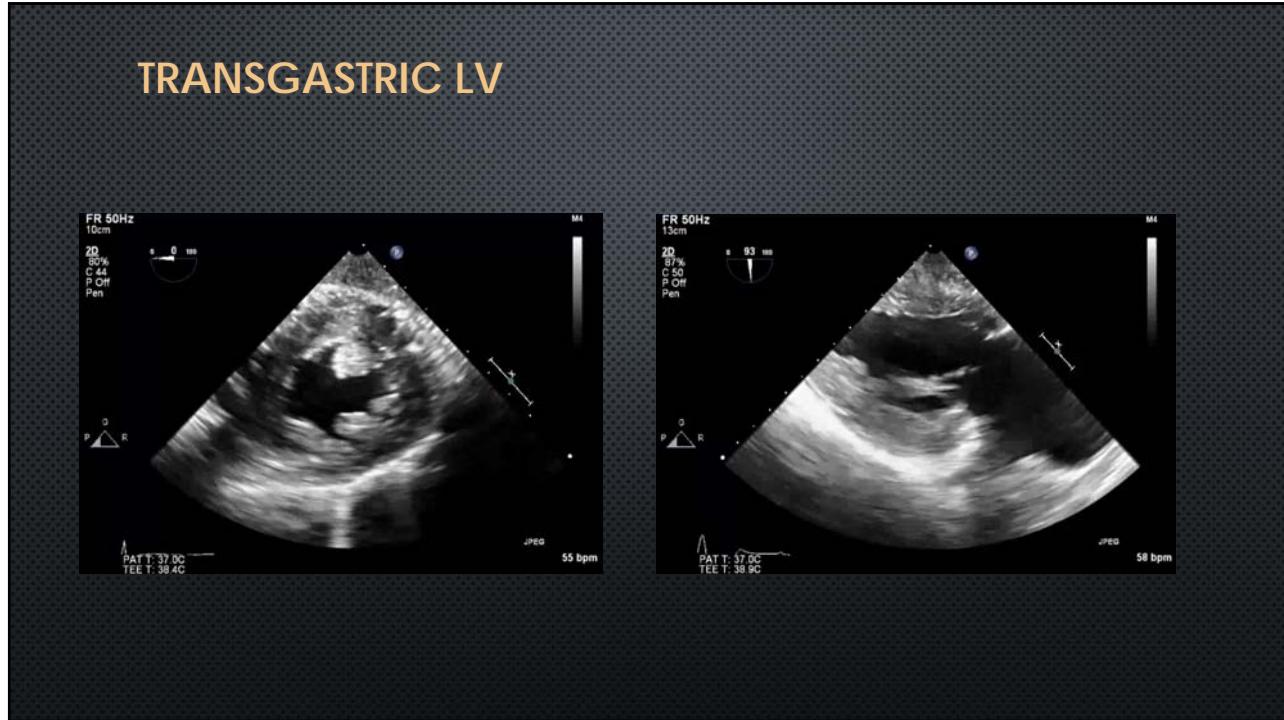
ME BUBBLE STUDY



TRANSGASTRIC SAX



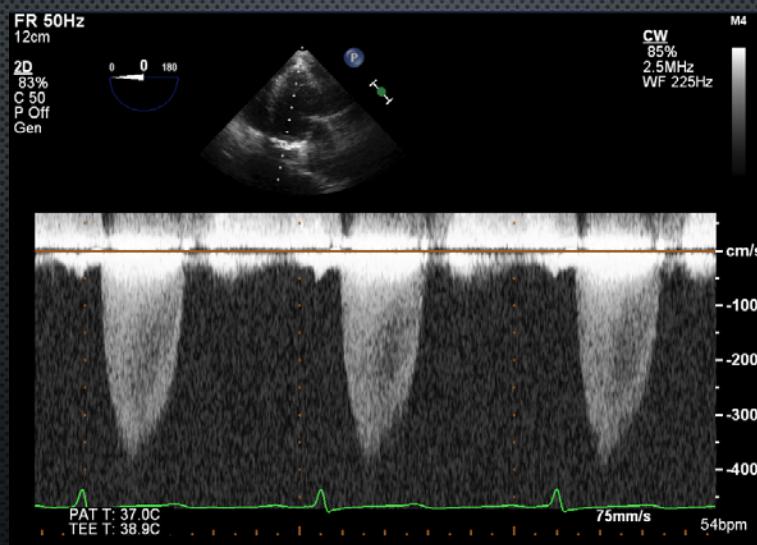
TRANSGASTRIC LV



DEEP TRANSGASTRIC



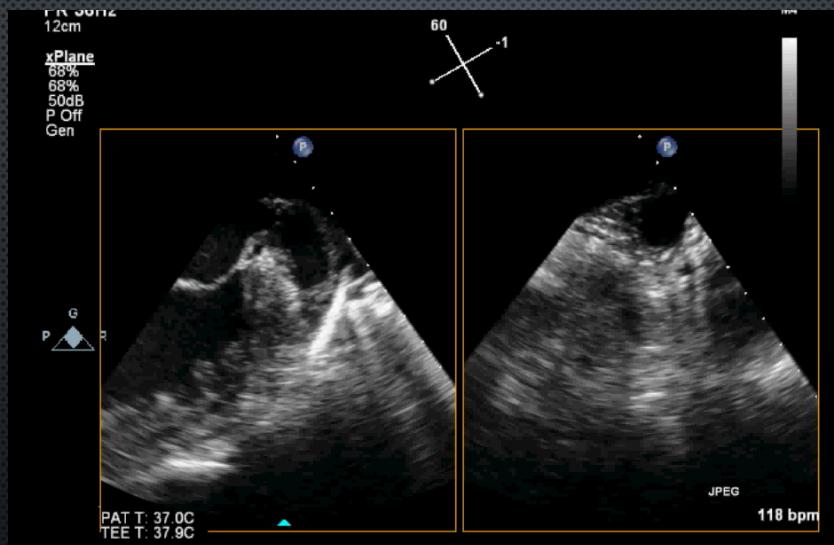
DEEP TRANSGASTRIC CW



"SPECIAL APPLICATIONS" OF TEE

- YOU SHOULD HAVE FAMILIARITY WITH THE FOLLOWING:
 - MULTI-PLANE IMAGING
 - 3D IMAGING
 - INTERVENTIONAL ECHOCARDIOGRAPHY
- YOU WILL NOT BE ASKED ABOUT WHETHER THE MITRAL CLIPPING DEVICE GRASP IS ACCEPTABLE...ETC...

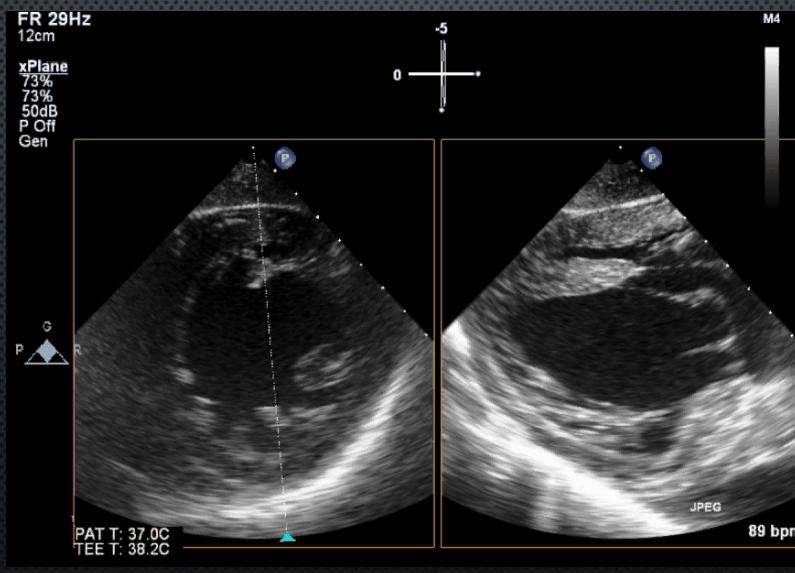
MULTIPLANE LAA



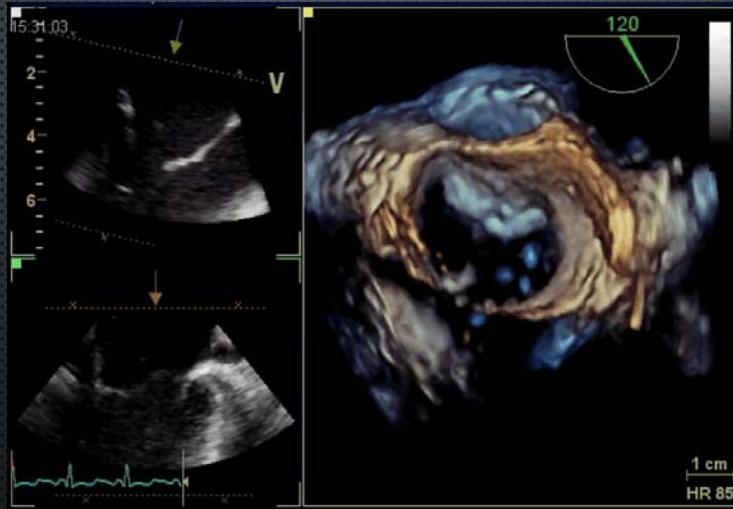
MULTIPLANE SVC



MULTIPLANE TRANS-GASTRIC

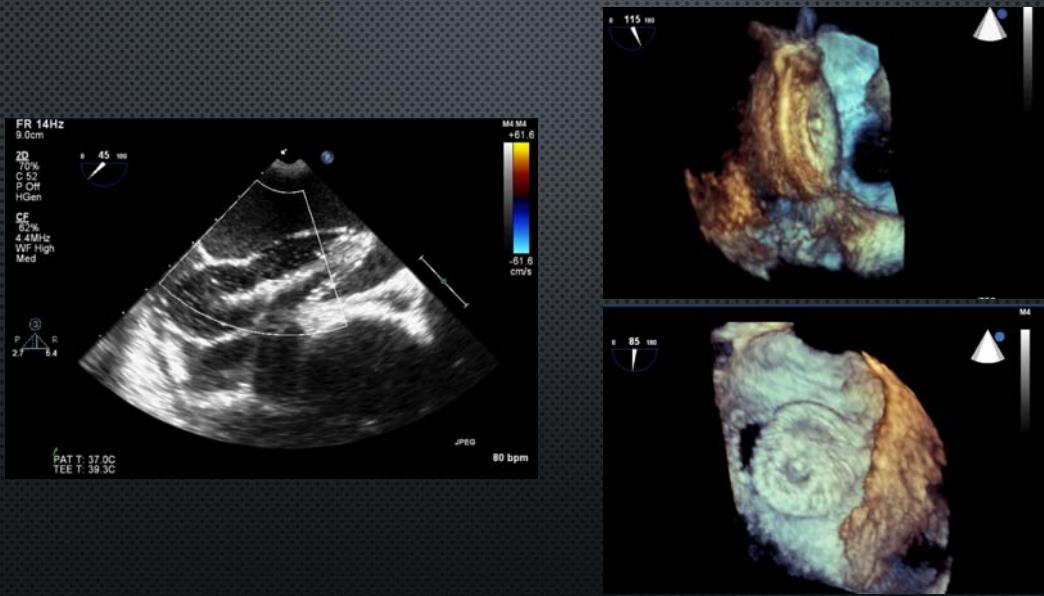


3D TEE IMAGING

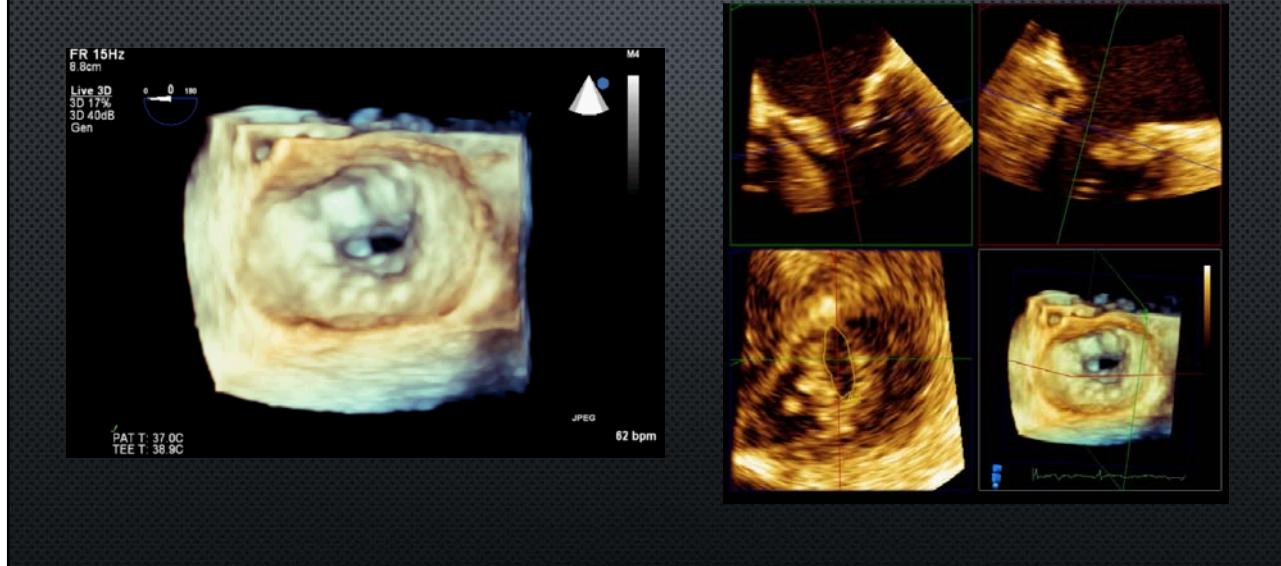


- LOTS MORE 3D IMAGING TO COME ON MONDAY...

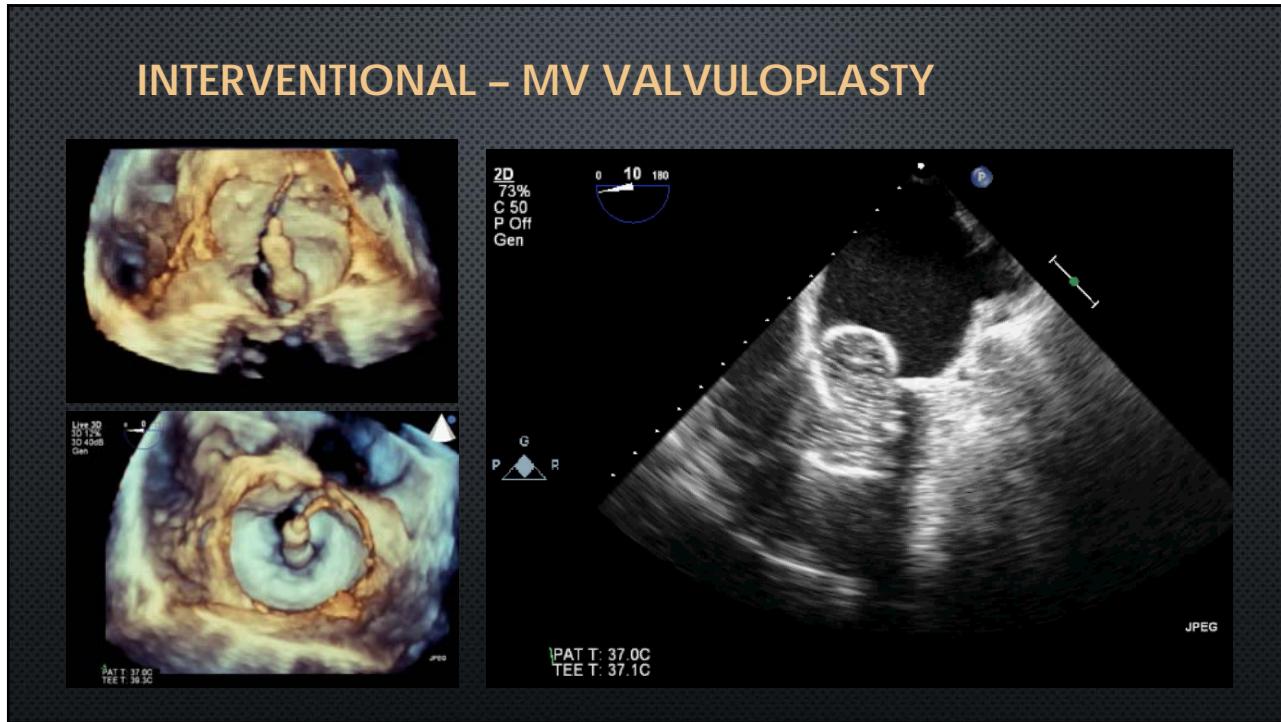
INTERVENTIONAL – ASD CLOSURE

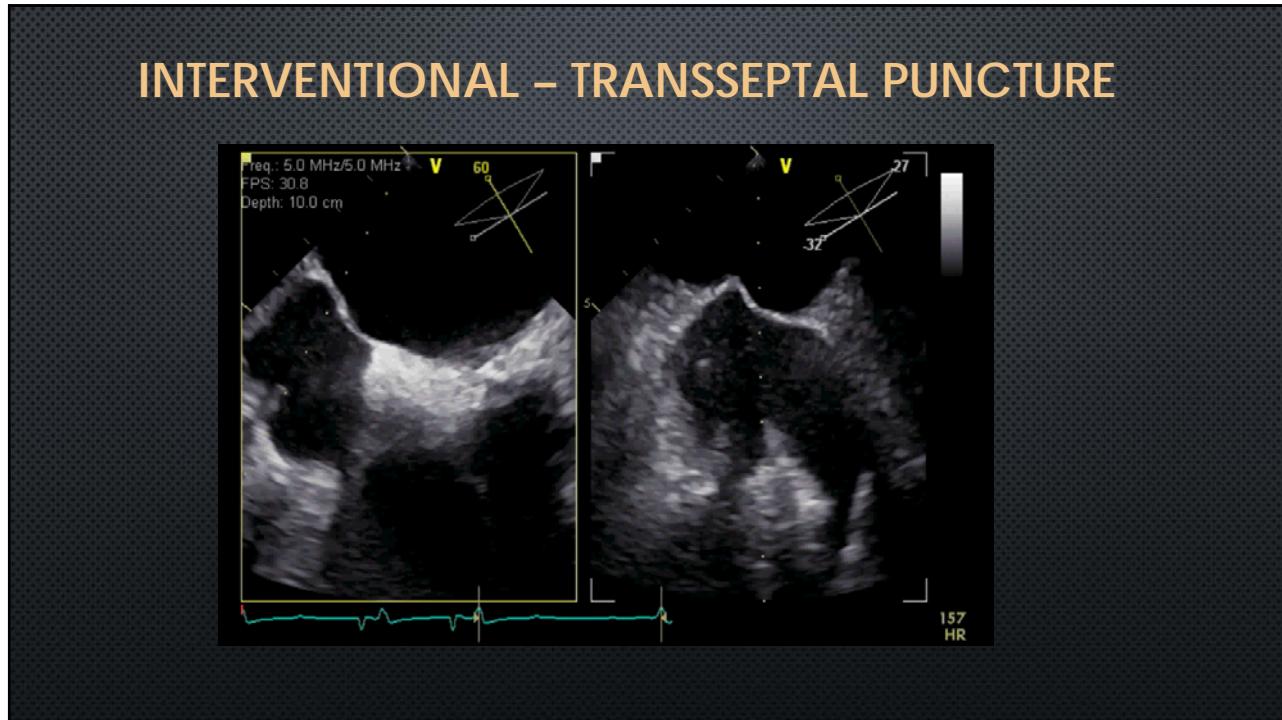
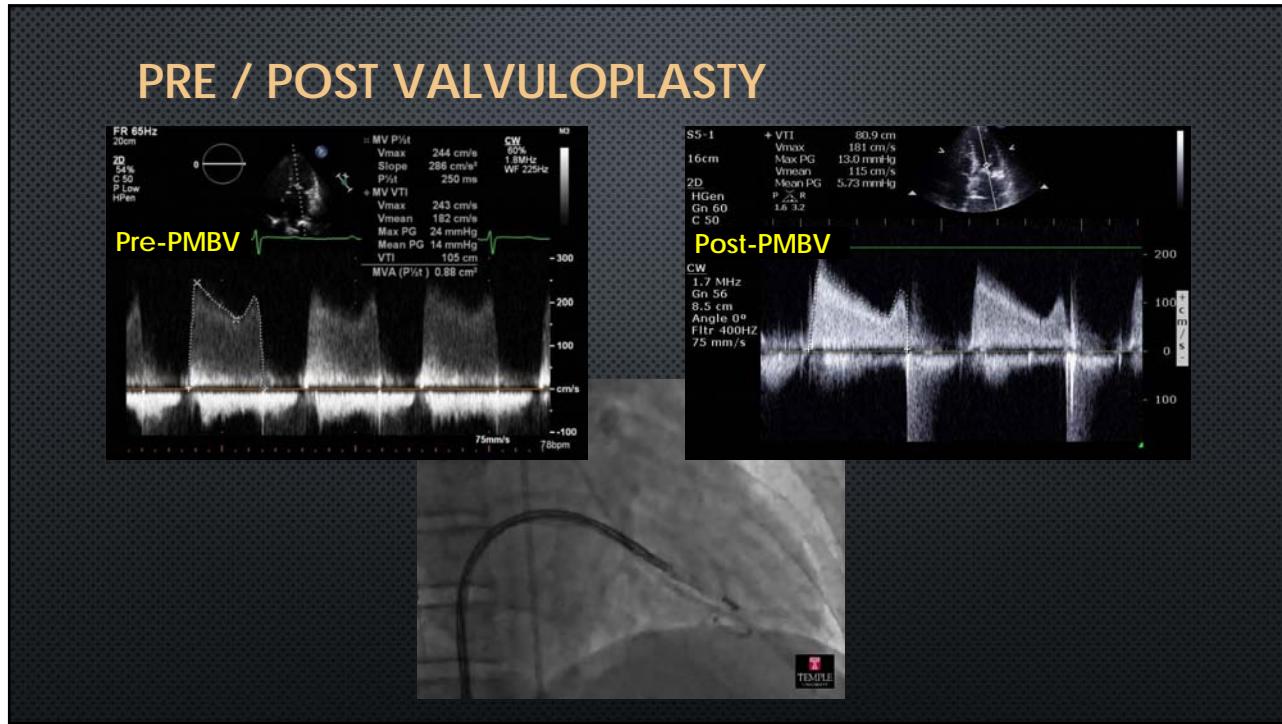


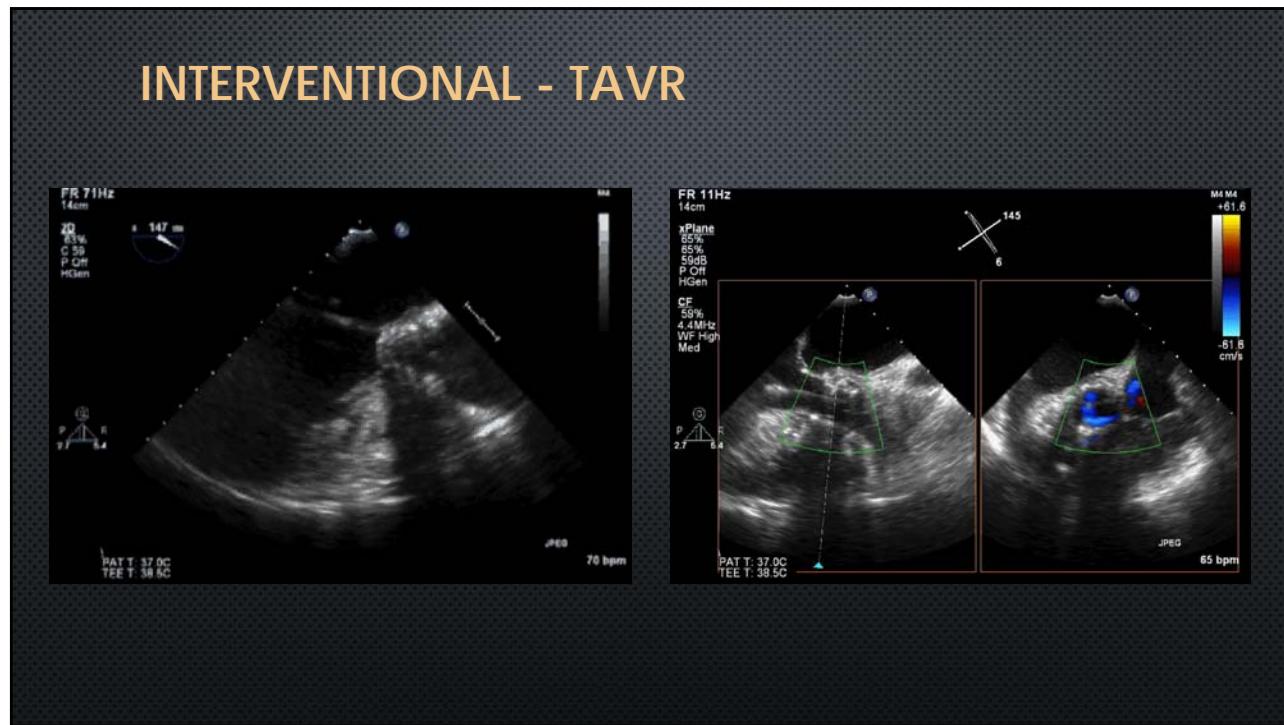
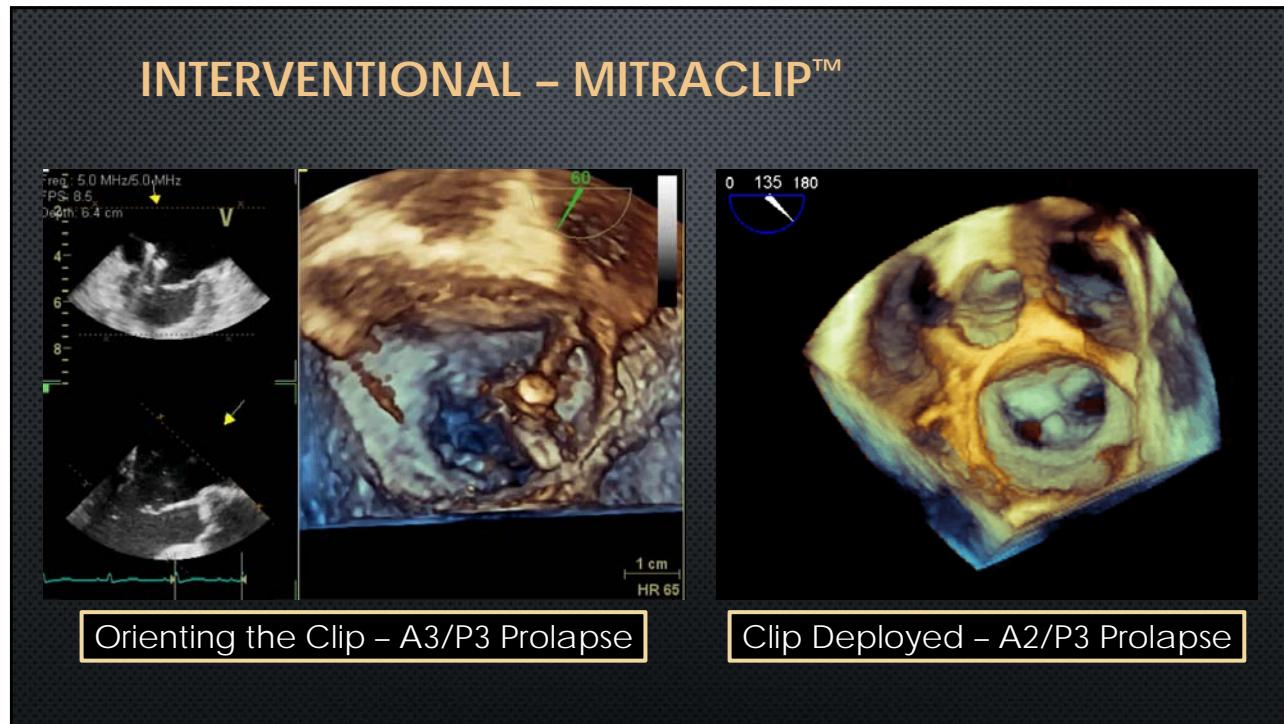
INTERVENTIONAL – MITRAL STENOSIS



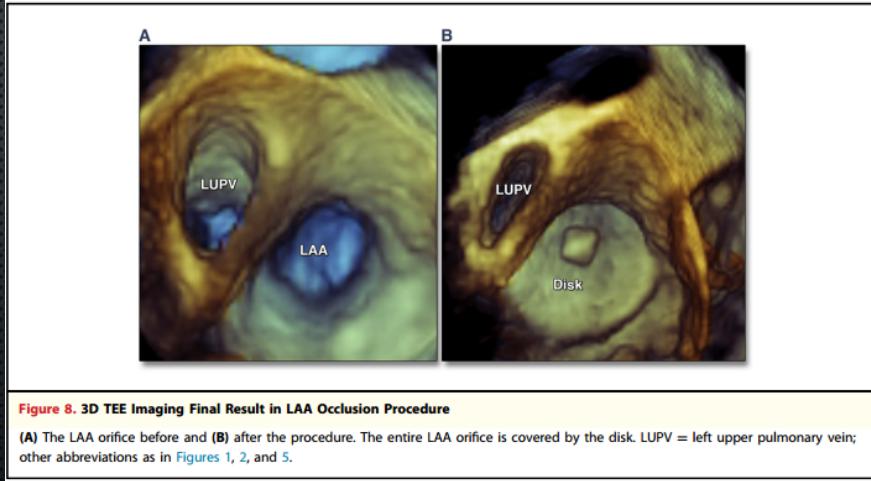
INTERVENTIONAL – MV VALVULOPLASTY





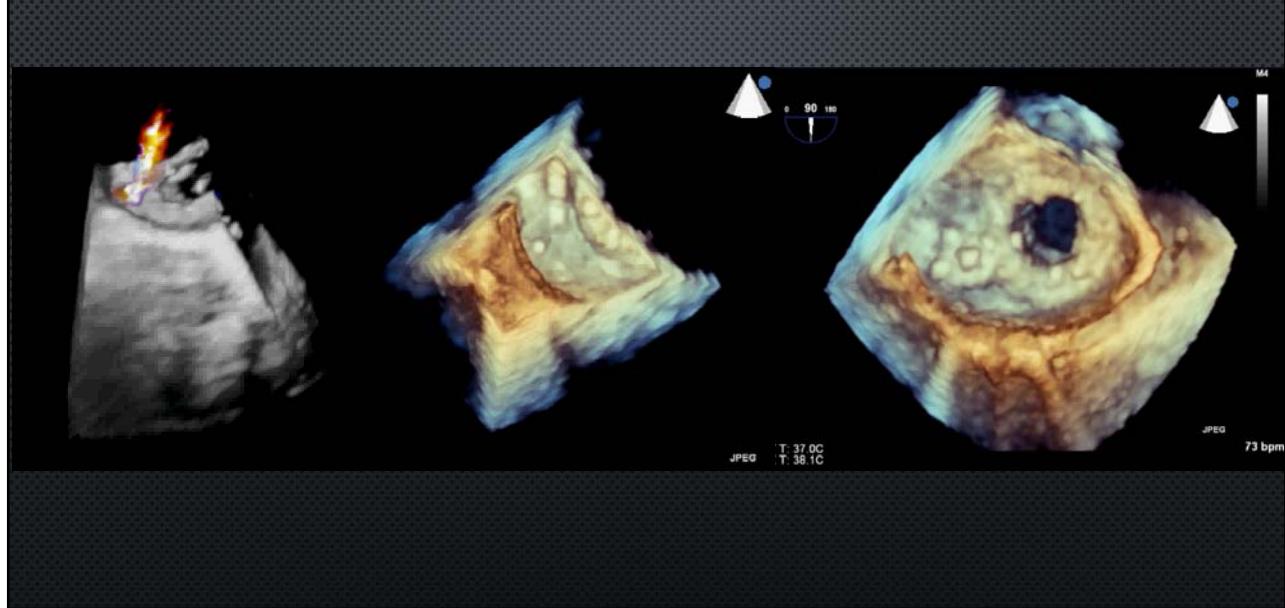


INTERVENTIONAL – LA APPENDAGE EXCLUSION



Faletra, et al. JACC Imaging (2014) 7:292-308

INTERVENTIONAL – PARAVALVULAR LEAK CLOSURE



SUMMARY – WHAT DO I NEED TO KNOW?

- INDICATIONS AND CONTRAINDICATIONS
 - MAJOR APPROPRIATE USE CONCEPTS (FORGET THE “U”-S)
- PATIENT EVALUATION AND PREPARATION
 - BOTH PROBE-RELATED AND SEDATION-RELATED
- COMPLICATIONS – DURING AND AFTER
- MAJOR VIEWS AND STRUCTURES
 - MEMORIZATION + PATTERN RECOGNITION
 - **MV SEGMENT ID ON PRIMARY 2D MAGE PLANES**
 - MULTIPANE IMAGES – MIND THE OMNI
- ADJUNCT TO INTERVENTIONAL PROCEDURES